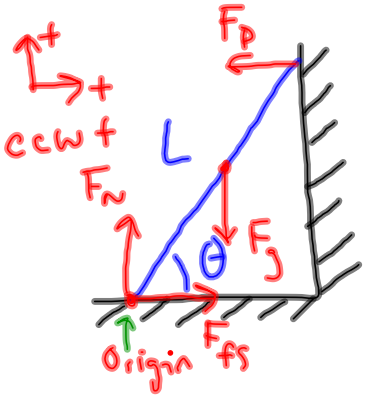
Static Equilibrium Practice Problem 10.24.11 AP Physics

A uniform ladder of length L rests against a smooth, vertical wall. The mass of the ladder is m, and the coefficient of static friction between the ladder and the ground is mu_s = 0.40. Find the minimum angle theta_min at which the ladder does not slip.



$$\Sigma F_x = 0$$

$$F_{fs} - F_p = 0 \qquad F_{fs} = \mu_s F_N$$

$$\mu_s F_N - F_p = 0$$

$$F_p = \mu_s F_N$$

$$\Sigma F_y = 0$$

$$F_N - F_g = 0$$

$$F_N = F_g$$

$$\Sigma \tau = 0 \qquad \sin(90-\theta) = \cos\theta$$

$$L F_p \sin\theta - \left(\frac{L}{2}\right) F_g \cos\theta = 0$$

$$L F_p \sin\theta = \left(\frac{L}{2}\right) F_g \cos\theta$$

$$\frac{\sin\theta}{\cos\theta} = \frac{F_g}{2F_p} = \frac{F_N}{2\mu_s F_N}$$

$$\tan\theta = \frac{1}{2\mu_s}$$

$$\theta = \tan^{-1}\left(\frac{1}{2\mu_s}\right)$$

$$\mu_s = \frac{1}{2\tan(60)} \qquad = 51.3°$$

$$= .28$$